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DIVISION OF MYCOLOGY AND DISEASE SURVEY

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CHARCOAL ROT IN ILLINOIS

L. R. Tehon and G. H. Boewe

Since 1913 charcoal rot has received considerable attention in phytopathological literature, and in the present decade a number of papers have dealt with it as a disease destructive to economically valuable plants in America.

The causal fungus, Rhizoctonia bataticola (Taub.) Butl. or Macrophomina phaseoli (Maubl.) Ashby, was first described, as to its sclerotial stage, by Taubenhaus (11, 12) as the cause of a sweetpotato storage rot. The number of hosts on which the fungus has been reported is now large, and the distribution of the fungus includes many parts of the world.

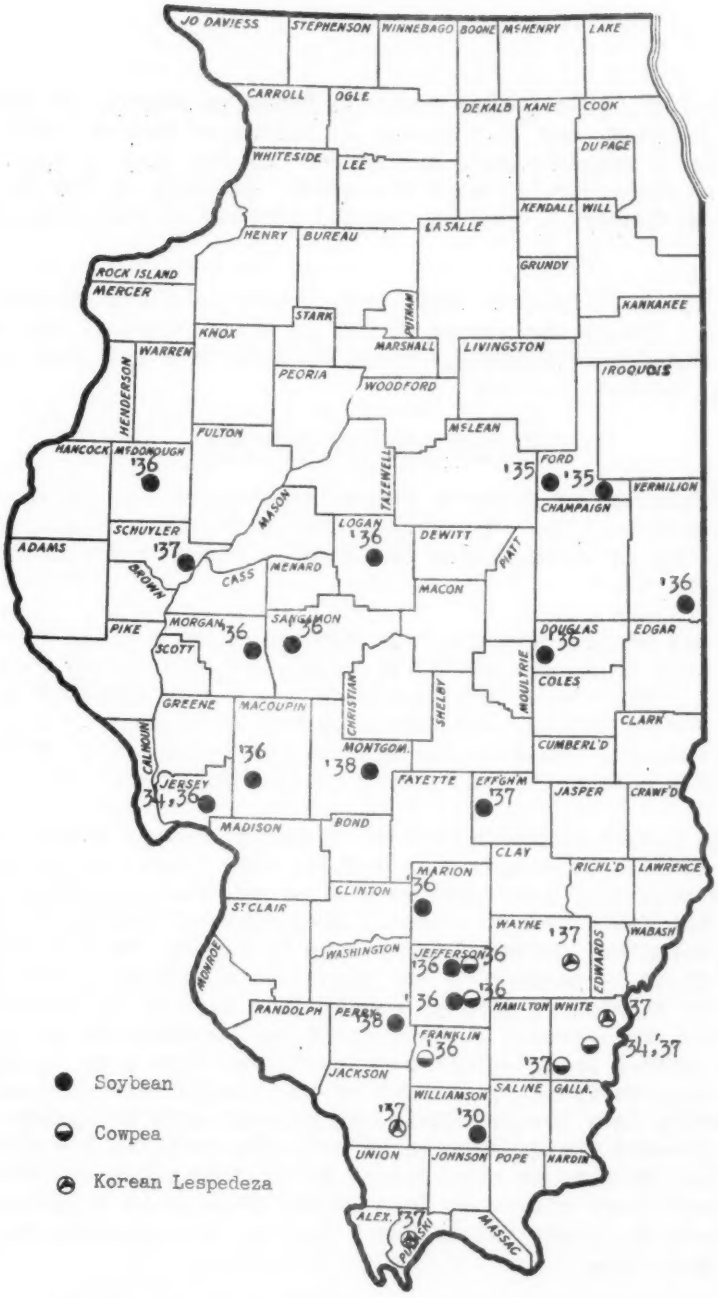
The fungus has been reported, as Rhizoctonia bataticola, on 20 herbaceous hosts and one woody host in India by Shaw and Ajrekar (10); on cotton, French bean, and cowpea in Egypt by Briton-Jones (2); on the common bean, pepper, coffee, Cacao, pea, Hevea, and Citrus by Ashby (1), who gives its distribution as Formosa, the Philippines, India, Ceylon, East Africa, Palestine, the West Indies, and eastern United States; on bean in Ceylon by Haigh (3, 4); on jute and cotton in Trinidad by West and Stuckey (16); on corn and bean in California by Mackie (7); on field bean in California by Kendrick (6); on dahlia in South Carolina by Post (8); on sugar beet in California by Tompkins (13, 14); on bean and cowpea in California by Tompkins and Gardner (15); on corn in Missouri by Schmitt (9); and, lastly, on Strophostyles helvola (L.) Brit. in Georgia by Johnson (5).

First record of its occurrence in Illinois is a collection made in 1926 by G. L. Stout on cowpea. Since then 51 additional records have been made of its occurrence in the State on both cultivated and wild hosts.

Charcoal Rot on Cowpeas

Since charcoal rot was first recorded on cowpeas in Washington County in 1926 it has been observed in cowpea fields in Jefferson, Franklin, and White Counties in 1930, 1931, 1934, 1936, and 1937. These four counties (see Map 1) lie north of the Ozark highlands in the southern part of the State and form, with neighboring counties, the East-West band in which the cowpea is the chief leguminous crop.

The three earliest collections were taken as samples of an unusual disease; hence, it may be assumed that the apparent damage was not sufficient to warrant the taking of statistical data. In 1932, however, notes made in connection with a collection in Jefferson County indicate greater severity. In an 80-acre field a plant here and there was diseased, and occasionally diseased plants made small patches. In 1934 counts made in a 3-acre field in White County indicated that 8 percent of the plants were



Record of Occurrence of Rhizoctonia bataticola (Taub.) Butl. (Macrophomina phaseoli) on Leguminous Crops in Illinois.
MAP I.

infected. In 1936, in a 5-acre field in Franklin County, .7 percent of the plants were infected; and in 3 fields in Jefferson County, each of approximately 5 acres, a single plant, 1.6 percent of the plants, and .3 percent of the plants, respectively, were diseased. In 1937, in two 8- or 9-acre fields in White County, 1 percent and 4.3 percent of the plants were diseased.

There is no indication of varietal susceptibility or resistance in these records. Two of the cowpea fields in which charcoal rot was found were unknown mixtures. Varieties known to have been infected are New Era, Whippoorwill, and Red Rippers.

Charcoal Rot on Soybeans

The occurrence of charcoal rot on soybeans was first recorded in Williamson County in 1930. Since that date infection has been found in 16 counties (see Map 1) representing the major portion of the southern two-thirds of the State.

No record of severity was made for the soybean field in which the disease was found in 1930, and the disease was not observed again on soybeans until 1934. In this latter year a severely infected 3-acre field was found in Jersey County, and counts showed that about 65 percent of the plants were diseased. In 1935 the disease was found in two fields in Ford County, but only a trace of the plants in each field were diseased.

In 1936 a much larger number of diseased soybean fields were encountered. In a 20-acre McDonough County field many plants in an area approximately 2 rods long by 2 feet wide were diseased, and occasional plants elsewhere in the field were diseased. In Jefferson County, in a cowpea field, a few volunteer soybean plants were diseased. In the same county, in a soybean field, 7 percent of the plants were diseased, the percent of diseased plants ranging in various counts from none to 14 percent. In Macoupin County, in a 5-acre soybean field, 6.8 percent of the plants were diseased, the number in 100-plant counts ranging from none to 22. In Marion County, in a 10-acre field, 7 percent of the plants were diseased; in Vermilion County, in a 10-acre field, 14 percent were diseased; in Douglas County, in a 40-acre field, 30 percent were diseased; in Jersey County, in a 40-acre field, 29 percent were diseased; in Morgan County, in a 30-acre field, .6 percent were diseased; in Sangamon County, in a 40-acre field, 8.5 percent were diseased; and in Logan County, in a 40-acre field, 2 percent were diseased.

In 1937, charcoal rot was found in soybean fields only in Schuyler and Effingham Counties. A 35-acre field in the first county had only a trace of diseased plants; a 5-acre field in the second county had .2 percent of the plants diseased.

In 1938 in Perry County, in a 10-acre field, 1 percent of the stems were diseased, and in Montgomery County, in a 15-acre field, .2 percent of the plants were diseased.

The difficulty of determining soybean varieties during ordinary field examinations has made it difficult to secure information regarding varietal susceptibility. The sowings were of mixed or undetermined varieties in many fields in which the disease was found. The varieties in which infection is known to have occurred are Virginia, Illini, Manchu, and Haberlandt.

Charcoal Rot on Korean Lespedeza

Charcoal rot was observed on Korean lespedeza only in 1937. It was recorded in Wayne, White, Jackson, and Pulaski Counties, all four of which (see Map 1) lie in the southern third of the State. Infection involved, in Jackson County, about 1 percent of the cover crop in a 5-acre orchard, in White County an average of 1 percent of the plants in a 10-acre field, in Wayne County approximately 10 percent of the plants in a 1-acre field, and in Pulaski County 3.5 percent of the plants in a 3-acre field.

Charcoal Rot on Corn

Charcoal rot was observed in Illinois cornfields only in 1937 and 1938. In the first of these years it was found in Madison, Perry, and Pulaski Counties, and in the second year in Effingham, Marion, Randolph, and Saline Counties. These counties (see Map 2) lie in the southern third of the State, and their distribution in that region suggests a more general occurrence of the disease there than present records prove.

From counts made in the infected fields, the amount of infection occurring in 1937 may be stated for the 20-acre field in Perry County as 15 percent and for the 10-acre field in Madison County as 28.5 percent, and in 1938, for the 40-acre field in Saline County as .5 percent, for the 20-acre field in Effingham County as 6 percent, for the 20-acre field in Marion County as 13 percent, and for the 3-acre field in Randolph County as 1 percent.

The region in which the disease has been found on corn lies south of the State's most intensive corn-growing district. The disease has been found on Democrat corn, open-pollinated yellow dent corn, white dent corn, and a white dent corn with some blue kernels.

Charcoal Rot on Wild Plants

In addition to the crops named above, the charcoal rot fungus attacks a number of wild plants in Illinois. It has been collected on wild hosts, as follows: on hemp (*Cannabis sativa* L.) in 1936 in Mercer County, on mares-tail (*Erigeron canadensis* L.) in 1938 in Adams and Champaign Counties,

Record of Occurrence of Rhizoctonia bataticola (Taub.) Butl. (Macrophomina phaseoli) on Corn in Illinois.
MAP II.

on prickly lettuce (Lactuca scariola L.) in 1938 in Adams County, and on velvet-leaf (Abutilon theophrasti Medic.) in 1937 and 1938 in eight widely distributed counties (see Map 3).

Distribution of Charcoal Rot in Illinois

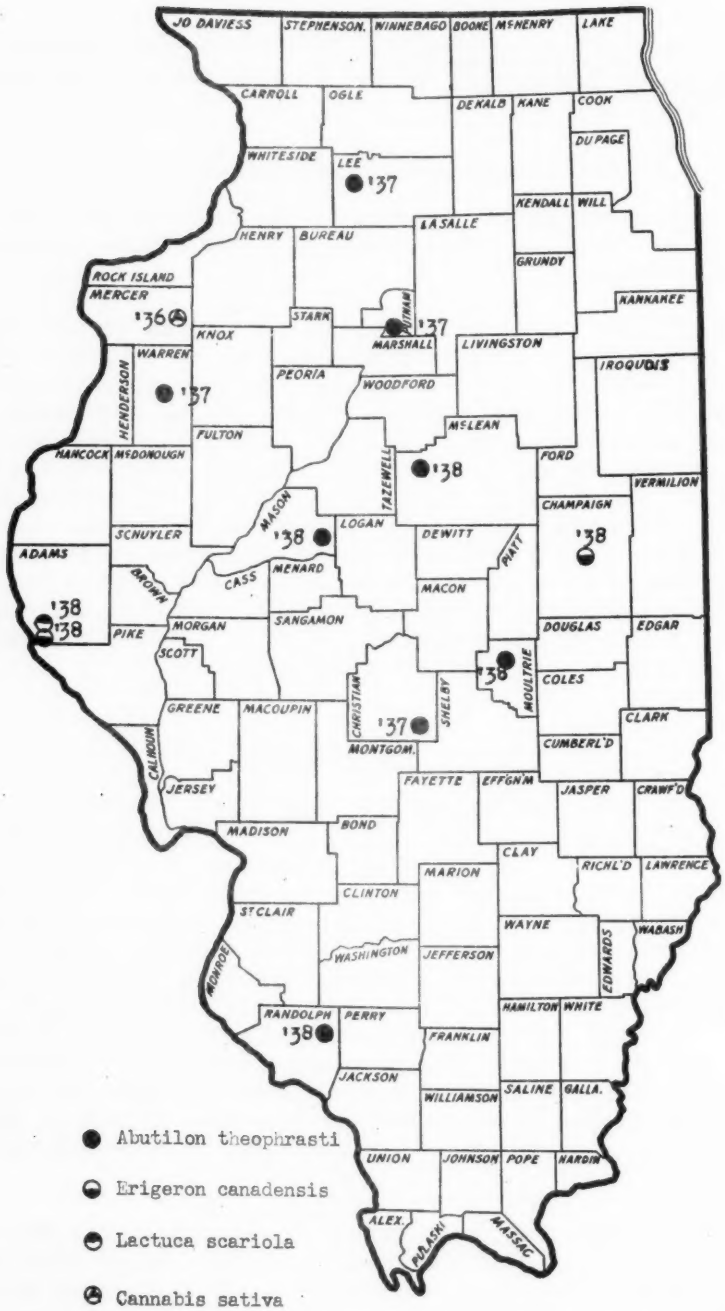
The known occurrences of charcoal rot in Illinois indicate that the fungus which causes the disease has practically state-wide distribution in the soils of the State.

Shaw and Ajrekar (10) have reported that strains of this fungus show specific host preferences. Our field data do not, as yet, give evidence of the occurrence of such strains in Illinois. The wide distribution of charcoal rot on legumes, shown in Map 1, appears to be correlated more closely with the distribution of these crops as a group than with a possible specialization in parasitism. Its limited range of occurrence on corn, shown in Map 2, is probably due to the frequent use, in the region where it occurs, of corn strains inferior in disease resistance to the carefully selected yellow dent strains grown throughout the northern two-thirds of the State. Records of charcoal rot on wild hosts are too few to be used to indicate the possibility of host specialization. The wide distribution of the disease on velvet-leaf might indicate either that only a single strain of the fungus is present in the State or that velvet-leaf is susceptible to more than one strain.

Attempts to Obtain Pycnidia

According to Ashby (1) Rhizoctonia bataticola (Taub.) Butl. and Macrophoma phaseoli (Maubl.) Ashby are sclerotial and pycnidial forms of the same fungus. Sawada (1916) reported production of minute sclerotia in cultures of a pycnidial fungus attacking jute. Shaw (10) found pycnidia and sclerotia constantly associated in the cortex of jute and obtained sclerotia in cultures derived from single pycnidiospores. Haigh (3, 4) produced pycnidia in cultures made directly from bean and pigeon pea and then obtained the sclerotial form in cultures originated as spore transfers from pycnidia. Post (8) reported that pycnidia developed in 18 days on acid corn meal agar in colonies originated by sclerotia from dahlia stems and that both pycnidial and sclerotial colonies developed from pycnidiospores produced in culture. Other investigators have failed to find pycnidia and sclerotia associated in the field and to secure pycnidia in culture.

Among the charcoal rot specimens collected in Illinois only one, that collected on cowpea in Jefferson County in 1931, bears both pycnidia and sclerotia. Hence it may be assumed that in the climate of Illinois production of sclerotia is the method of reproduction normal for the fungus, unless a number of collections on cowpea, tentatively identified as Macrophoma subconica Ellis & Everh., which bear no sclerotia, should prove to represent the pycnidial form.



Record of Occurrence of Rhizoctonia bataticola (Taub.) Butl. (Macrophomina phaseoli) on Wild Hosts in Illinois.
MAP III.

Attempts to obtain pycnidia of the charcoal rot fungus in cultures originated from Illinois material have failed under the following circumstances.

From fragments of infected corn stalk, attempts were made to isolate and grow the charcoal rot fungus on Difco corn-meal and potato-dextrose agars, without and with light and moderate acidulation of the media (1 and 2 drops respectively of 25 percent lactic acid to 10 ml. of medium). On unacidulated corn-meal agar isolations were obtained readily, and the fungus grew to the full extent of the Petri plates in from 14 to 21 days, producing sclerotia in abundance but failing, over a period of two months, to produce pycnidia. On lightly and moderately acidulated corn-meal agar and on unacidulated potato-dextrose agar isolations were not obtained. But on both lightly and moderately acidulated potato-dextrose agar isolations were readily obtained, and the fungus grew rapidly, covering the entire plate area in 10 days or less, and produced sclerotia very abundantly but failed, in a period of 2 months, to produce pycnidia.

From fragments of infected soybean stem, attempts were made to isolate and grow the charcoal rot fungus on the same variety of media used for corn. On unacidulated corn-meal agar the fungus grew very slowly, the colony reaching a diameter of only 1 1/4 inches in 14 days, developing in that period only the white rudiments of the sclerotia, and failing to develop pycnidia in the course of 2 months. On lightly and moderately acidulated corn-meal agar and on the unacidulated and the 2 acidulated potato-dextrose agars isolations were not obtained.

Attempts to isolate the charcoal rot fungus from infected stems of Erigeron canadensis failed with each of the media described above.

Isolates from both corn and soybean, obtained on unacidulated corn-meal agar, grew rapidly after being transferred to autoclaved sweet clover stems and produced sclerotia in abundance; they had not, however, produced pycnidia on the sweet clover stems at the end of 2 1/2 months.

Size of Sclerotia in Illinois Material

Haigh (4) divided the sclerotia of Rhizoctonias on various hosts into groups designated A, B, and C, on the basis of size. His C group, in which the sclerotia were limited to an average diameter of 120 microns or less, he considered to represent the sclerotial stage of Macrophomina phaseoli. As a criterion for identification of the charcoal rot fungus, Haigh's grouping has been used by several American investigators, notably Post (8), Kendrick (6), Tompkins and Gardner (15), and Tompkins (14).

Measurements of sclerotia developed in the tissues of infected plants (not measurements of sclerotia developed in culture) are given in Table 1 for the 8 species of plants known to be attacked in Illinois by

Table 1. Measurements of Sclerotia of Rhizoctonia bataticola from Various Hosts.

Host Species	Length, in microns			Width, in microns			Ratio of mean length to mean width
	Mean	Extremes	Mean deviation	Mean	Extremes	Mean deviation	
Abutilon theophrasti	86.1	54 - 109	.16	68.5	54 - 82	.11	1.25
Cannabis sativa	73.9	27 - 163	.31	43.9	27 - 54	.20	1.68
Erigeron canadensis	81.6	41 - 122	.24	67.1	34 - 109	.27	1.22
Glycine hispida	77.7	41 - 136	.18	63.3	41 - 82	.14	1.23
Lactuca scariola	58.9	41 - 68	.15	53.3	41 - 68	.16	1.10
Lespedeza stipulacea	84.7	54 - 109	.13	64.9	54 - 82	.10	1.30
Vigna sinensis	85.8	68 - 95	.09	74.8	68 - 95	.11	1.15
Zea mays	73.4	41 - 109	.28	54.9	27 - 82	.26	1.34

the charcoal rot fungus. As to their means, all of these measurements are less than the maximum mean of 120 microns permitted for inclusion in Haigh's C group, thus indicating that in respect to size of sclerotia these Illinois fungi are similar to those sclerotium-bearing fungi which, reported from many parts of the world, are at present included under the name Macrophomina phaseoli.

Considerable variation in both extreme and mean measurements has been reported for sclerotia from different host species and for sclerotia from the same host species. The range in size of sclerotia from dahlia, given by Post (8), is 62 to 117 microns for sclerotia developed in dahlia tissues and 40 to 80 microns for sclerotia developed in culture. The mean diameter of sclerotia developed in culture from field bean, according to Kendrick (6), is 75.4 microns, but sclerotia in cultures from the same host, according to Tompkins and Gardner (15), may also have mean diameters of 81.9 and 109.7 microns.

The mean diameter of 85.8 microns given in Table 1 for sclerotia developed in cowpea tissue differs from the mean diameter of 121.6 microns reported by Tompkins and Gardner (15) for sclerotia developed in culture, and the extreme diameters of 41 to 109 microns given in Table 1 for sclerotia developed in the tissues of cornstalks differ from the diameters of 50 to 200 microns given by Mackie (7). Also, the measurements given in Table 1 for sclerotia from the 8 host species listed there differ appreciably in means and extremes according to host.

In view of such variations in size of sclerotia and the possible differentiation of the fungus into races adapted in parasitism to specific hosts, measurement characteristics other than means and extremes may prove

useful for distinguishing the different races. We furnish in Table 1 the mean deviation (applied to length and width measurements separately) and the ratio of mean length to mean width for sclerotia from the 8 plant species attacked by charcoal rot and suggest that these measurement characteristics or others of similar nature can serve a useful purpose, along with the means and extremes usually considered important, in the identification of host races.

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(Section of Applied Botany and Plant Pathology, Illinois State Natural History Survey).

TWO DISEASES OF POTATO NEWLY REPORTED FROM MASSACHUSETTS

O. C. Boyd

Bacterial wilt and soft rot disease [presumably bacterial ring rot (Bacterium sepedonicum)] of potatoes was found in Massachusetts this fall. It was observed in the Chippewa and Warba varieties on a farm in Hawley, Franklin County, on September 13, and in Green Mountain potatoes in Hatfield, Hampshire County, on September 25. In the latter instance, the infected tubers at harvest were in the early-to-medium stages of decay, while in another field on the same farm planted with the same stock, and dug 8 to 10 days earlier, the grower observed none of the disease.

A severe case of pink rot (Phytophthora erythroseptica) was observed on a farm in Worthington, Hampshire County, on September 7. All the typical symptoms described for this disease, that is, wilt, root and lower stem rot and tuber decay, were present. The wilt symptoms did not develop until shortly before the tops matured. The disease was much more prevalent in areas of several fields where decayed tubers were dumped from the storage last January and February.

(Massachusetts State College, October 6).

[NOTE: This is the second report to the Survey of the presence of pink rot in this country. Last year Reiner Bonde reported pink rot and wilt, caused by species of Phytophthora, including P. erythroseptica, from Maine (PDR 22: 460. Dec. 15, 1938).]

SPECIES OF PHYTOPHTHORA RESPONSIBLE FOR MARKET DECAY OF WESTERN HONEY DEW MELONS AND CANTALOUPS

James S. Wiant

Representative isolates of Phytophthora obtained by the writer from decaying Honey Dew melons and cantaloups received on the New York market during September 1938 (Plant Disease Reporter 22: 404-408. 1938) were studied and identified by C. M. Tucker of the University of Missouri. Dr. Tucker reports that all but one of the 11 isolates were Phytophthora capsici Leonian. This species was represented by 9 isolates from Honey Dew melons shipped from various points in Colorado (including La Junta, Ordway, Manzanola, and Rocky Ford) and one isolate from a cantaloup also of Colorado origin.

A single isolate from a cantaloup in a carlot shipped from Green River, Utah was found to be P. cactorum (Leb. & Cohn) Schroet.

(Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, New York City).

BRIEF NOTES AND A REQUEST

PLANT DISEASE NOTES FROM GEORGIA: Downy mildew [Pseudoperonospora cubensis] has shown up in the fall cucumber plantings, both for the pickle industry and for table stock. In the areas affected there is rather heavy infection, which was fostered by a somewhat unseasonable period of wet, cold weather.

Several cases of nematode [Anguina tritici] infestation in the current wheat crop in North Georgia have been reported. (Huey I. Borders, Extension Plant Pathologist. October 6).

DISTRIBUTION OF BACTERIAL RING ROT OF POTATO. A REQUEST FOR REPORTS: The map on page 289 of the September 15 issue is obviously incomplete. It was presented to call attention to the insufficiency of the Survey records on this important disease, which is known to be present in many States from which no direct report has been received. The apparent concentration of distribution is due to the very complete reports from Nebraska and Wyoming. Similar reports from other States would be appreciated.

SEPTEMBER WEATHER

(From Weekly Weather and Crop Bulletin for week ending October 3).

The month of September, as a whole, was characterized by abnormally high temperatures throughout the interior of the country and widespread, marked deficiencies in precipitation. High temperatures for the season persisted until the last week of the month when abnormally cool weather overspread the Northwest. In the interior, between the Appalachian and Rocky Mountains there was very little precipitation until near the close of the month when light to moderate showers were widely distributed. In fact, one of the most severe and widespread droughts of record developed throughout the Plains States and central valley districts.

Notwithstanding the late-month showers, it was the driest September of record in some interior sections, while in others rainfall was the smallest in many years. The monthly totals at Keokuk, Iowa, 0.2 inch, and Springfield, Ill., 0.1 inch, were the smallest of record for September, while Lincoln, Nebraska, Dodge City, Kansas, and Chicago, Illinois, had the driest September in more than 40 years. On the other hand, the south Pacific area had abnormally heavy rains, especially southern California and New Mexico. Los Angeles with a monthly normal of 0.2 inch had 5.7 inches of rain, equalling an accumulated normal for nearly 30 Septembers.

Figure 1 shows the departure of temperature from normal for the month. Throughout the interior of the country it was one of the warmest Septembers of record, with the monthly mean temperatures ranging from 4° to as many as 9° above normal. The month was warmer than normal everywhere, except very locally in the extreme Northeast, along the Gulf coast, and in

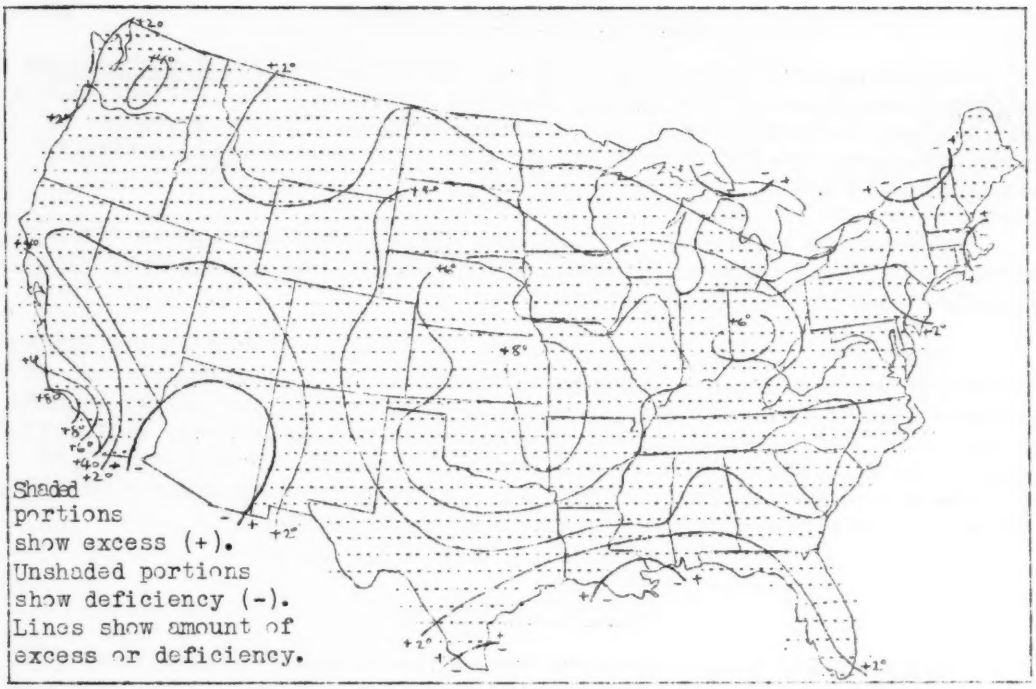

Figure 1. Departure of mean temperature from the normal for September 1939.

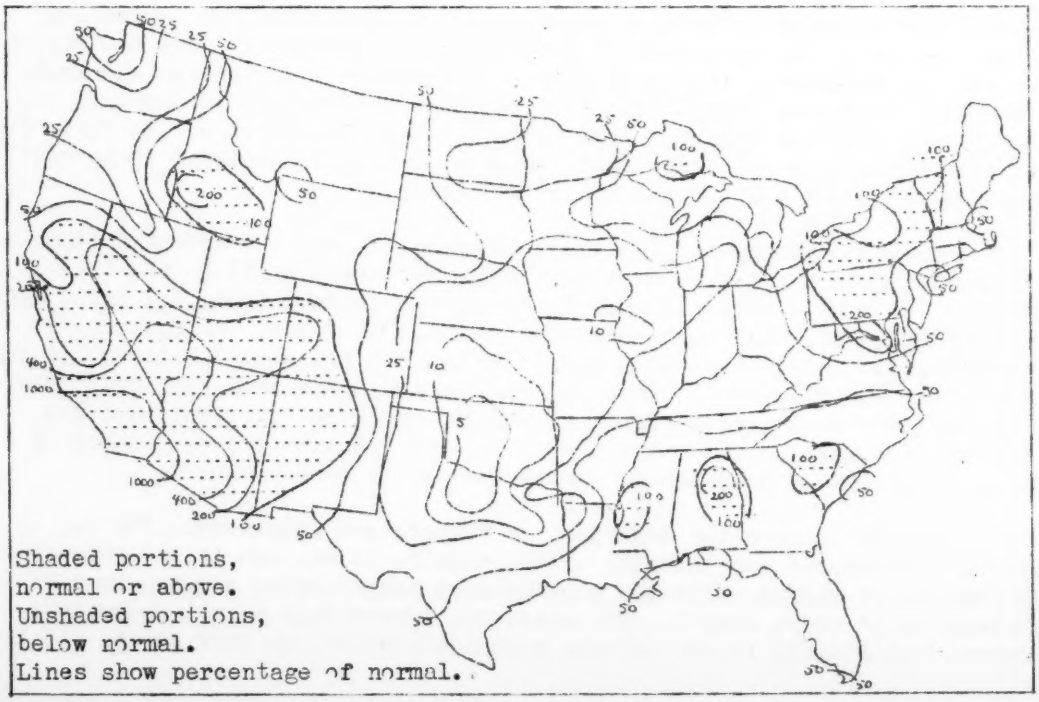

Figure 2. Percentage of normal precipitation for September 1939.

the far Southwest. Figure 2 shows the percentage of normal precipitation as reported from first-order Weather Bureau stations. The relatively driest area is shown for the upper Mississippi and lower Missouri Valleys and in the central and southern Plains States where considerable areas had less than 10 percent of normal rainfall. A large southwestern area had abnormally heavy rains.